ORIGINAL

DOCKET FILE COPY ORIGINAL

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
Guidelines for Evaluating the Environmental Effects of Radiofrequency Radiation	)	ET Docket No. 93-62
	)	

RECEIVED

AUG 12 1993

FCC - MAIL ROOM

TO: The Commission

COMMENTS OF WAYNE OVERBECK[1]

The following comments are offered in response to the Commission's Notice of Proposed Rule Making in the above captioned matter. In particular, I wish to address the implications of this proceeding for the amateur radio service. At Appendix A, I am placing in the record a paper I recently published that discusses the possible effect of the proposed rules on *weak signal DXers*, the class of amateur radio operators most likely to utilize high gain directional antennas and high power in the VHF-UHF region.

AMATEUR RADIO LICENSEES AND EMR HAZARDS

In recent years I have given more than 50 presentations to groups of radio amateurs about the possible hazards of electromagnetic radiation--at venues ranging from the "Dayton Hamvention" (America's largest gathering of amateur radio operators) and national conventions of the American Radio Relay League (ARRL) to local club meetings.

---

[1] I am a Professor of Communications at California State University, Fullerton, and hold Ph.D. and J.D. degrees. I have a research interest in the biological effects of radiofrequency radiation. During the early 1980s I assisted in the preparation of the broadcast industry's Comments in an earlier FCC proceeding on this matter (Docket No. 79-144) as an employee of the Legal Department of the National Association of Broadcasters. I later helped to prepare materials on rediofrequency radiation hazards for amateur radio publications as an elected official of the American Radio Relay League. However, I am neither an employee of NAB nor an elected official of ARRL now; the opinions expressed in these Comments are my own and do not necessarily reflect the views of any organization.

No. of Copies rec'd 0+9
List A B C D E

In so doing, I have found that very few radio amateurs are aware of the electromagnetic radiation levels present near their own amateur stations. While most amateurs have read media accounts of studies linking electromagnetic radiation to various health problems, very few of them have even the slightest knowledge of the ANSI C95.1-1992 standard that they would be asked to observe in this proceeding. Very few have any means of accurately measuring r.f. power densities. And virtually no amateur licensee has the resources to conduct the kind of environmental review that is typically required of other FCC-licensed services.

Does this mean radio amateurs should continue to be exempted from compliance with r.f. safety standards? In my view, the answer is *no*. It would be unconscionable to exempt the amateur service--given what we know today about the potential health hazards of electromagnetic radiation. Amateurs usually operate in a residential environment. Their activities inevitably expose family members and neighbors (as well as amateurs themselves) to unknown levels of r.f. radiation. Some amateurs use the maximum transmitter power permitted by the Commission's rules. Some also utilize very high gain antennas for long-distance communication, not only at HF but also in the VHF-UHF region most impacted by the 1992 ANSI standard. While the majority of amateurs do not engage in any activity that results in hazardous exposures to r.f. energy, some clearly do use equipment capable of producing radiation levels exceeding even the ANSI standard for *controlled environments*, as the Commission's 1990 field survey of amateur radio stations indicated.[2] However, most amateurs have no knowledge of the potential hazards this may pose for them, their families or neighbors. Under these circumstances, it would seem prudent to

---

[2] R.F. Cleveland, E.D. Mantiply and T.L. West, "Measurements of Environmental Electromagnetic Fields Created by Amateur Radio Stations," presented at the 13th annual meeting of the Bioelectromagnetics Society, Salt Lake City, Utah, June, 1991.

apply the standard for *uncontrolled environments* to the amateur service. The Commission cannot ignore amateurs in formulating rules to assure compliance with C95.1-1992.

However, applying the Commission's customary environmental processing procedures to amateurs would create many practical difficulties. What is needed instead is a major educational effort, in which the Commission can play a crucial role by adopting appropriate rules for the amateur service.

EDUCATING AMATEURS ABOUT RADIATION SAFETY

Several amateur radio publishers, most notably ARRL, have taken steps to educate amateurs about the potential hazards of electromagnetic radiation. Recent editions of both *The ARRL Handbook* and *The ARRL Antenna Book* have included extensive discussions of this topic. However, operating practices that ignore radiation safety concerns are sufficiently widespread in the amateur service that they inevitably show up in amateur publications. For example, the June, 1993 issue of *QST* (the nation's most widely read amateur radio magazine) featured a full-page front cover photograph of an amateur sitting outside his car, only a few feet away from several portable VHF-UHF antennas. The accompanying article indicated that substantial transmitter power (on the order of 100 watts output to the antenna) was employed, resulting in operating conditions that very likely placed the amateur in an r.f. field exceeding the ANSI standard. And yet, the article contained no warning about the possible hazards of such an open-air operation with antennas in close proximity to people.

About a year earlier, *QST* published a photograph of an indoor antenna that was disguised as a curtain (or perhaps more correctly, a valance).[3] The valance/antenna was

---

[3] See "Up Front in QST," in *QST*, April, 1992, page 12.

within a few feet of the operating position. There was no warning in the accompanying text that using moderate or high power with such an antenna could expose the amateur and his family to excessive r.f. radiation.

Clearly, if amateurs are to observe good r.f. radiation safety practices, a major educational campaign is needed. As indicated earlier and explained in Appendix A, I do not believe amateurs or the Commission have sufficient resources for the traditional kind of environmental processing of amateur stations. Not only would that impose prohibitive costs on many amateurs, but it could inundate the Commission with paperwork from the nation's 600,000 amateur licensees. Moreover, because amateurs routinely change their antenna configuration, transmitter power and their station location, amateurs would be obliged to submit numerous supplemental environmental impact statements as their operating activities evolved.

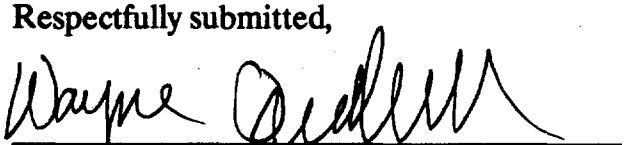
I think a more practical way to maximize amateur compliance with ANSI C95.1-1992 would be to add a rule to Part 97 requiring amateurs to adopt operating and antenna-placement practices calculated to meet the exposure limits--accompanied by a chart showing how far from populated areas various antennas should be, given various transmitter powers and operating frequencies. The chart that appears in Appendix B at page 25 of the instant Notice is an excellent starting point. It could be expanded to include other examples, such as a directional antenna with 15-20 dB. gain over a dipole (such antennas are often used by amateurs in the VHF-UHF region). The chart might show safe heights for directional antennas having clean radiation patterns as well as worst-case scenarios (e.g., an antenna with major sidelobes, or one pointed directly toward a nearby residence). The calculations underlying such a chart should be based on the 1992 ANSI standard for uncontrolled environments.

If all amateur license examinations included questions that would test the applicant's understanding of such a chart, the Commission could greatly increase amateurs' awareness of the real-world circumstances in which their activities might result in inappropriate r.f. radiation exposures--to themselves, their families or neighbors.

CONCLUSION

Radio amateurs have a long record of voluntary compliance with the Commission's rules. While it is clear that many amateurs have little knowledge of r.f. radiation hazards (let alone an accurate means of measuring the fields associated with their stations), I believe the FCC could greatly increase amateur compliance with ANSI C95.1-1992 by including a clearly written rule in Part 97 detailing those amateur activities most likely to result in excessive exposures. While amateurs should be informed about good r.f. safety procedures (and required to practice them), the Commission's traditional environmental processing system would seem impractical for the amateur service. On the other hand, if amateurs are given clear guidelines to follow in their operating procedures and the placement of their antennas, I believe most will make a good faith effort to comply.

Respectfully submitted,



Wayne Overbeck (N6NB)
Department of Communications
California State University, Fullerton
Fullerton, CA 92634

August 10, 1993

APPENDIX A

Reprinted from the *Proceedings of the 27th Conference of the Central States VHF Society*, published by the American Radio Relay League, Inc., Newington, CT, 1993., p.26-33.

EMR and Weak Signal DXing: The FCC May Change the Rules

By Wayne Overbeck, N6NB

There has been growing concern about the possible health effects of electromagnetic radiation (EMR) in recent years. The news media often carry accounts of new medical research on the topic, and numerous lawsuits have been filed by persons claiming that various illnesses were caused by EMR. This concern encompasses everything from the 60-Hz magnetic fields produced by high-tension lines to VHF-UHF-microwave energy from cellular telephones, radar systems, television and radio transmitters and microwave ovens.

While separating fact from fantasy is difficult in any evolving field of scientific inquiry, the problem has been greatly complicated in the case of EMR by both the emotional nature of the public debate and the huge financial stakes for industry if EMR levels must be reduced to protect public health. If it can be shown conclusively that children living near high-tension lines have abnormally high rates of leukemia (as a number of studies conducted in several different countries have already indicated), the cost to electric utilities (and indirectly to all of us as ratepayers) could run into billions of dollars. Many power lines would have to be relocated, and wider buffer zones would have to be created along those that cannot be relocated for one reason or another.

The stakes are also high for radio amateurs. We must consider not only the health issue itself but also the potential public reaction. We are already under fire for the appearance of our antennas and the problem of r.f.i. If health concerns are added to this litany of complaints, we may face severe restrictions by local governments.

At this point, new research about the biological effects of EMR is reported in medical journals almost weekly. While there is a great deal that we still do not know, there is strong evidence that it does have health effects, even at low levels. This evidence comes from two different kinds of research: epidemiological studies of public health patterns and laboratory research into the effects of EMR on human and animal tissue.

Although there are many uncertainties in this field, and some of the research has yielded contradictory results, there is now sufficient evidence of health hazards that governments, private industry, and even radio amateurs cannot ignore the problem. There have been voluntary national standards for exposure to RF energy for many years, adopted by the American National Standards Institute (ANSI). These standards have been repeatedly revised downward in light of the growing evidence of health hazards even at low energy levels. The latest ANSI standard, designated as ANSI C95.1-1992,[1] is sufficiently strict that certain amateur radio activities exceed the exposure guidelines.

As users of high-power transmitters and high-gain antennas in the VHF-UHF region, weak signal DXers may be more impacted by this issue than any other group within amateur radio. The Federal Communications Commission is considering new rules that could require weak signal operators to show that they comply with the 1992 ANSI standard. Although the Commission has been requiring many licensed services to show compliance

with the previous ANSI standard since 1985, amateurs have been categorically exempt. However, in ET Docket No. 93-62, the FCC is considering a proposal to eliminate the exemption for amateurs. *This could mean that amateurs--or some amateurs, at least--would be subject to environmental processing of their license applications and/or renewals.* That could place a new regulatory burden on amateurs, and having to review amateurs' environmental compliance statements would substantially increase the FCC's workload. The FCC is seeking public comments concerning Docket 93-62; the deadline is August 13, 1993.

AN OVERVIEW OF EMR AND HEALTH

Much has been written in amateur radio publications and elsewhere about the question of EMR and health. In fact, the American Radio Relay League has a Committee on the Biological Effects of RF Energy that regularly monitors new research in this field. Ivan Shulman, WC2S, chairman of the Bio-Effects Committee, wrote a detailed article about the problem for *QST* several years ago.[2] More recently, new sections were added to both *The ARRL Handbook* and *The ARRL Antenna Book* covering RF safety issues.

To summarize briefly, both RF and low frequency fields are classified as *nonionizing radiation* because the frequency is too low for there to be enough photon energy to ionize atoms. *Ionizing radiation*, on the other hand, has a variety of very serious (and well publicized) adverse health effects. But nonionizing radiation also has health effects.

It has been known since the early days of radio that at sufficiently high levels RF energy could heat body tissue enough to cause blindness, sterility and other health effects. What we are learning today is that even at *athermal levels* (levels too low to cause body heating) there are also demonstrable health effects. We know, for instance, that low frequency magnetic fields, as well as RF fields that are keyed, modulated or pulsed at a low frequency rate, affect the manner in which human cells intercommunicate. Cancer-fighting T-cells in the immune system rely on subtle chemical and electrical messages that pass through the cell membrane to determine that a particular cell has become cancerous. It has been shown in laboratories that low-level EMR can alter this vital communication through the cell membrane.[3] Other laboratory research has shown that low level EMR can disrupt the human body's circadian rhythms (the body's internal "clock"), cause chromosome damage, and alter the body's level of melatonin, a hormone that reduces the risk of certain cancers if present in appropriate quantities.[4]

Research has shown that EMR at levels even weaker than the Earth's geomagnetic field has biological effects. How can this be? The Earth's magnetic field as a *static* field. All of life has evolved in this constant field. Natural electromagnetic fields are also created by the sun and thunderstorm activity; life as we know it has adapted to those fields. However, in the last 100 years, man-made fields with very different intensities and spectral distributions have altered the natural electromagnetic environment in ways that have their own biological effects.

In addition to the laboratory research that has identified biological effects of EMR, there has now been extensive epidemiological research into EMR and health. In fact, Dr. Samuel Milham's much-publicized 1988 medical journal article about amateur radio and cancer was based on an epidemiological study of the mortality rates of amateurs in California and Washington state.[5] The study noted statistically significant excess mortality among

radio amateurs from two kinds of cancer, but did not prove there was a causal link.

There have been many other studies correlating occupational exposure to RF and/or low-frequency fields with higher than normal rates of various cancers, most notably leukemia, non-Hodgkins lymphoma and brain cancer (Milham's study of amateurs found significant excess mortality from the first two, but not from brain cancer). As noted earlier, a number of studies have shown that children living near high-tension lines have higher than normal rates of leukemia. The recent nationwide Swedish studies confirmed earlier findings of both excess leukemia among children living near high-tension lines and abnormal rates of certain cancers among workers exposed to high levels of EMR.[6] Another study found that microwave workers with 20 years of exposure to EMR had 10 times the normal rate of brain cancer if they were also exposed to soldering fumes or electronic solvents. Typically, these chemical factors alone increase the risk about twofold.[7]

On the other hand, there are some nagging questions that remain unanswered. Several studies of workplace EMR exposures and health have yielded contradictory results. Often spot measurements of electromagnetic fields do not correlate with the observed health effects, even within homes near power lines. There is also evidence that there may be *window effects*: Some studies have shown health effects at certain *frequencies* but not at others (e.g., 25-30 Hz and 45 Hz, but not 35-40 Hz), at certain *field intensities* but not in stronger or weaker fields, and in certain relationships to the Earth's static magnetic field but not others. The normal adage about carcinogens, "If some is bad, more is worse," may not apply to EMR. We appear to be dealing with very subtle and complex relationships between EMR and health.

In view of the uncertainties in this field, many public health officials are now urging "prudent avoidance," the common-sense idea that it is wise to avoid unnecessary exposure to EMR until there is a more complete understanding of its health effects. This philosophy has led some countries (notably Sweden) to adopt exposure standards far more stringent than even the new 1992 ANSI standard. And in the United States, the National Council for Radiation Protection and Measurement has adopted a voluntary standard that in some respects is considerably stricter than the new ANSI standard. In fact, the ANSI committee that adopted the new standard was criticized by some public health researchers for being excessively influenced by industry groups with a financial stake in the status quo.

Be that as it may, the new ANSI standard exists, and the FCC now proposes to use it as a processing guideline for licensed services.

THE NEW ANSI STANDARD

There has been considerable debate within the medical and scientific community about the question of standards for exposure to EMR. This is a complex problem, involving difficult public health and economic tradeoffs. The ANSI standard has been revised downward several times in recent years, and there are many who question whether the new ANSI C95.1-1992 standard is adequate. The new 1992 ANSI standard is, however, much more restrictive than the 1982 version--which was itself 10 times stricter in the VHF range than the pre-1982 standard.

The new standard has been promulgated by ANSI in cooperation with the Institute of Electrical and Electronic Engineers (IEEE). Basically, the 1992 standard departs from

the previous one in several important ways, including the following:

*C95.1-1992 establishes two different exposure standards. One is more liberal and is intended for *controlled environments* such as workplaces where the electromagnetic field intensities are known and everyone exposed to EMR is aware of the potential hazards. The second, stricter standard is for *uncontrolled environments* where there is exposure to members of the public or other persons who may not be aware of the EMR levels.

*The 1992 standard specifies an E-field exposure limit of 1.0 mW/cm^2 (61.4 volts/meter) in the 30-300 MHz range in controlled environments, which is unchanged from the 1982 standard. However, in uncontrolled environments, the limit has been set five times lower: 0.2 mW/cm^2 in the 30-300 MHz range. Fig. 1 (at the end of this paper) shows the portions of C95.1-1992 that are most relevant to VHF-UHF amateur radio operation.

*The new standard requires that in most cases these field strengths and their equivalent plane wave power densities are to be averaged over six minutes in controlled environments and over 30 minutes in uncontrolled environments.

*The 1992 standard sets limits for induced and contact RF currents in the body, something the old standard did not do.

*The 1992 standard modifies the much-criticized exemption for RF devices with an input power of 7 watts or less, eliminating the exemption altogether for devices that have any "radiating structure" within 2.5 cm. of the body and limiting the exemption to devices with effective radiated power of 1.4 watts or less in uncontrolled environments in the 100-450 MHz range. The new standard exempts devices with e.r.p. below 7 watts in the 100-450 MHz range only if they are used in controlled environments and have no radiating structure within 2.5 cm. of the body.

Much that is in the new ANSI standard remains controversial. For example, its time-averaging rules are based on estimates of the ability of the human body to dissipate heat. However, time averaging may not be appropriate in considerations of the athermal effects of EMR. Also, the new standard does not make special provisions for modulated signals, despite the growing evidence that an RF signal modulated by a low frequency (3 to 100 Hz) may pose hazards that do not exist with unmodulated carriers.

The ANSI standard is less strict than the standard adopted by the National Council on Radiation Protection and Measurement (identified by the acronym, NCRP). NCRP is a non-profit corporation chartered by Congress and composed of members who serve on its various scientific committees. Several government agencies, including the FCC, maintain official relationships with NCRP as collaborating organizations. The NCRP standard differs from the new ANSI standard in several respects, perhaps most notably in that it takes into account the biological effects of modulation and does not allow higher EMR exposures in controlled environments.[8]

How does the ANSI standard compare with the EMR levels found in amateur radio? In 1990, the FCC and U.S. Environmental Protection Agency (EPA) jointly conducted a field survey of EMR levels at the stations of volunteer radio amateurs in Southern California.[9] This writer accompanied the FCC and EPA researchers during some of their field survey work. Briefly, they concluded that most amateur radio activities do not produce EMR levels that would exceed the new ANSI standard. However, they noted the following exceptions of interest to VHF-UHF operators:

*Within a radius of 1-2 meters around a VHF mobile whip antenna fed by a 100-

watt-output transmitter, the field strength is likely to exceed the exposure limits for uncontrolled environments.

*When an indoor or attic-mounted antenna is used at VHF with a power level of 100 watts or more, there may be hot spots in the home (in the near field of the antenna) where the field strength exceeds the ANSI standard for uncontrolled environments.

*A portable or other low-height directional antenna, when used with high transmitter power, may produce field strengths at ground level in front of the antenna that significantly exceed the ANSI standard for uncontrolled environments and may even exceed the standard for controlled environments.

The FCC/EPA team did not measure the field intensities associated with an e.m.e. station because no e.m.e. station owner could be found who was willing to volunteer to participate in these measurements. However, there can be little doubt that a moonbounce station, which may deliver 250,000 watts of e.r.p. or more, is capable of producing fields that exceed the ANSI standard, particularly if the array is pointed at the horizon.

THE NEW FCC PROPOSAL

Shortly after the new ANSI standard was adopted, the FCC's Office of Engineering and Technology developed a Notice of Proposed Rule Making (NPRM) to implement it for the Commission's environmental processing of license applications and renewals. This NPRM was developed under the direction of Dr. Robert Cleveland, the FCC scientist who led the field survey of amateur radio stations in 1990. He has also conducted similar surveys of electromagnetic fields near other FCC-licensed transmitting facilities.

The NPRM (ET Docket No. 93-62) proposes to adopt the new ANSI standard in lieu of the old 1982 standard, which the Commission has been using as the basis for its environmental review of licensees since 1985. Under previous FCC policies, the Commission has required applicants to state whether their operations would produce EMR levels exceeding the ANSI standard. If so, a further "environmental assessment" has been required. Up to now, amateur radio stations have been categorically exempt from this environmental processing.

In and of itself, replacing the old ANSI standard with the new one might not be a major concern for radio amateurs. However, there are several proposals within Docket 93-62 that could significantly affect amateurs--especially those who use high transmitter power and high antenna gain in the VHF-UHF region, such as weak signal DXers.

First, the Commission is seeking comments on the possibility of deleting the exemption from environmental processing for radio amateurs. At paragraph 19, the NPRM says:

> Some of the current categorical exclusions may not be consistent with the provisions of the new 1992 ANSI/IEEE guidelines. *This may be true with regard to certain currently excluded facilities and operations such as some amateur radio stations...* (emphasis added)

Environmental processing could be particularly troublesome for weak signal operators because the NPRM proposes to use the new ANSI standard for uncontrolled environments for amateurs (and other services operating in residential areas), not the more lenient

standard for controlled environments. There can be little doubt that some amateur activities will produce fields in excess of these exposure limits some of the time.

The NPRM also asks for public comments about practical ways in which stations that have been exempt from this environmental processing could be brought into compliance with the new ANSI standard. That may pose a difficult challenge, inasmuch as the equipment required to make accurate field measurements of EMR is expensive and requires frequent recalibration. In an appendix, the NPRM suggests that it might be possible to estimate the RF fields likely to be encountered by calculations--without conducting actual measurements. However, the appendix does not indicate what would happen if an amateur station changes its frequency, transmitter power, antenna gain, or antenna height. Portable or mobile operation poses still other problems. What about a station providing communications along a crowded parade route?

The FCC now bases its initial environmental processing on information provided in application forms. That is appropriate for broadcast stations, which operate at specific fixed power levels with a specified antenna configuration and location. Given the penchant of radio amateurs to change transmitters and antennas (not to mention changing their operating frequencies--or roving in VHF contests), conducting environmental assessments of amateur radio stations would create many practical problems--for amateurs and the Commission's already overburdened staff. Would each change in an amateur station's operating parameters trigger a new environmental assessment and more paperwork?

Perhaps of greatest interest to amateurs, the NPRM also seeks comments and suggestions for "any changes to our rules that may be necessary to ensure compliance with the RF exposure guidelines, e.g. *general power reductions in a service or other restrictive measures*" (paragraph 20, emphasis added). It could be that the only way to assure amateur compliance with the new ANSI standard would be to reduce the power limit substantially and forbid the use of any antenna in close proximity to any person. But since most amateurs stations now meet the new ANSI standard, wouldn't that be regulatory overkill? And if there were a general power reduction, enforcement could be a problem, since thousands of amateurs have a substantial investment in high-power amplifiers. Also, a power reduction would make some amateur activities such as moonbounce work far more difficult.

How should radio amateurs respond to Docket 93-62?

At this writing, the American Radio Relay League has not adopted an official position by vote of its Board of Directors. (The League undoubtedly will have a position on 93-62 by the time the Central States VHF Conference is held in late July, because the Board will meet shortly before the conference and the comment deadline is August 13.)

It is clear that Docket 93-62 puts responsible amateurs in a difficult position. The argument that amateur radio should be categorically exempt because amateurs do not exceed the ANSI standard is untenable under the new standard for uncontrolled environments. And we can hardly ask to be placed under the more liberal standard for controlled environments when few amateurs, and even fewer of their families and neighbors, are aware of the EMR levels present in their homes and neighborhoods. We cannot really say that our families and neighbors are "aware of the potential for exposure as a concomitant of employment" (as the ANSI C95.1-1992 document says everyone must be for a facility to be governed by the controlled environment standard).

On the other hand, it is obvious that there are enormous practical problems that must be solved if radio amateurs are to comply with ANSI C95.1-1992. And, of course, the

implications of a general power reduction for the amateur service are so far-reaching and complex that they extend far beyond the scope of Docket 93-62. In fact, up to now there has been little discussion of the implications of Docket 93-62 by radio amateurs.

As we face a difficult new regulatory challenge, perhaps only one thing is certain now: we can never again ignore the health implications of EMR as so many of us did in the laissez-faire days before 1988, when newspaper headlines around the world announced the results of Dr. Sam Milham's study of the cancer rates of radio amateurs.

REFERENCES

1. See ANSI/IEEE C95.1-1992, "Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields (3 kHz to 100 GHz)," adopted by the American National Standards Institute, New York, NY, November 18, 1992.

2. Ivan Shulman, "Is amateur radio hazardous to your health?" OST, Oct 1989, pp 31-34.

3. W.R. Adey, "Electromagnetic fields, cell membrane amplification, and cancer promotion," in B.W. Wilson, R.G. Stevens, and L.E. Anderson, Extremely Low Frequency Electromagnetic Fields: The Question of Cancer. Columbus, OH: Batelle Press, 1989, pp 211-249.

4. For a summary of the research cited in this article, see W.R. Adey, "Electromagnetic fields and the essence of living systems," Plenary Lecture, 23rd General Assembly, International Union of Radio Sciences (URSI), Prague, 1990. In: J. Bach Andersen, ed., Modern Radio Science. Oxford: Oxford University Press, pp 1-36.

5. S. Milham, "Increased mortality in amateur radio operators due to lymphatic and hematopoietic malignancies," American Journal of Epidemiology, 1988; 127:50-54.

6. See M. Feychting and A. Ahlbom, "Magnetic fields and cancer in people residing near Swedish high voltage power lines," IMM-Rapport, Stockholm, 1992.

7. T.L. Thomas et al., "Brain tumor mortality risk among men with electrical and electronic jobs: a case-controlled study," Journal of the National Cancer Institute, 1987; 79:223-237.

8. National Council on Radiation Protection and Measurements (NCRP), "Biological effects and exposure criteria for radiofrequency electromagnetic fields," NCRP Report No. 86. Bethesda, MD: 1986.

9. R.F. Cleveland, E.D. Mantiply, T.L. West, "Measurements of environmental electromagnetic fields created by amateur radio stations," presented at the 13th annual meeting of the Bioelectromagnetics Society, Salt Lake City, Utah, June 1991.